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Comparative Assessment of Variations in Some Physicochemical Parameters of Rain Water Samples from Dutsin-Ma Local Government Area of Katsina State, Nigeria

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ABSTRACT
This study was carried out to determine the quality of rainwater from zinc roofs and direct raindrops in Dutsin-Ma Local Government Area of Katsina State, Nigeria. Samples were taken to the laboratory and analyzed using standard analytical procedures. The average result obtained ranged 5.67 - 6.51 0.73 - 2.61 NTU, 27.10 – 28.61^{O}C, 0.10 – 0.91 mg/L, 4.30 – 19.60, and 0.040 - 0.291mg/L for pH, turbidity, temperature, total dissolved solids, nitrate nitrite respectively. Rain water samples collected from zinc roofs gave high turbidity content than direct raindrops. Also, rain water from zinc roofs gave high TDS compared to direct raindrops. The physico-chemical properties of the harvested water from the zinc roofs were considerably different from those of water collected directly from raindrop. This signifies the effect of rain drop on the zinc roof could be as a result of anthropogenic inputs (deposits of pollutants in contact with zinc sheet. However, considering the result of the analysis, all the values of the physico-chemical properties and anions content of the water samples were within the WHO maximum acceptable limit for drinking water. Hence, the harvested water could be put to domestic use.
Keywords: rainwater, Dutsima-Ma, variations

INTRODUCTION

Water is an essential natural resource for sustainability of life on earth. Humans may survive for several weeks without food, but barely few days without water because constant supply of water is needed to replenish the fluids lost through normal physiological activities, such as respiration, perspiration and urination (Shalom *et al.*, 2011). The issue of rainwater harvesting is now a widely used technique for the provision and supply of both portable and non-portable supply of water especially in developing Worlds where the potable water are insufficient to meet the growing needs of the society due to rapid industrialization and development as well as population growth (Olaoye and Olaniyan, 2012). Of all the rainwater harvesting methods, the rainwater runoff from household roofs is the most common form of rainwater harvesting Potable water, also called drinking water about its intended use, is defined as water which is fit for consumption by humans and other animals (Tchobanoglous *et al.*, 2003) The usual sources of drinking water namely streams, rivers, rain, wells and boreholes are mostly untreated and associated with various health risks. Paucity of infrastructure for effective treatment and distribution of water accounts for the incidence of high morbidity and mortality rate associated with water borne diseases in developing countries (Shalom *et al.*, 2011). A tremendous amount of attention has been directed toward pollution of water supplies and the subsequent effects on the life of many animals and human (Odeyemi & Agunbiade 2012)

In many areas, rainwater is still considered as a safe and suitable source of potable water, and it is commonly used as such (Cobbina *et al.,* 2013; Oklo & Asemave, 2012;). The World Health Organization (WHO) estimated that about 4.6 million people die each year from causes directly attributed to air pollution (Srivastava & Pandey 2012). Therefore, a good knowledge of the chemical qualities of rainwater through regular physicochemical analysis is necessary so as to guild its suitability (Okonkwo *et al.,* 2008).

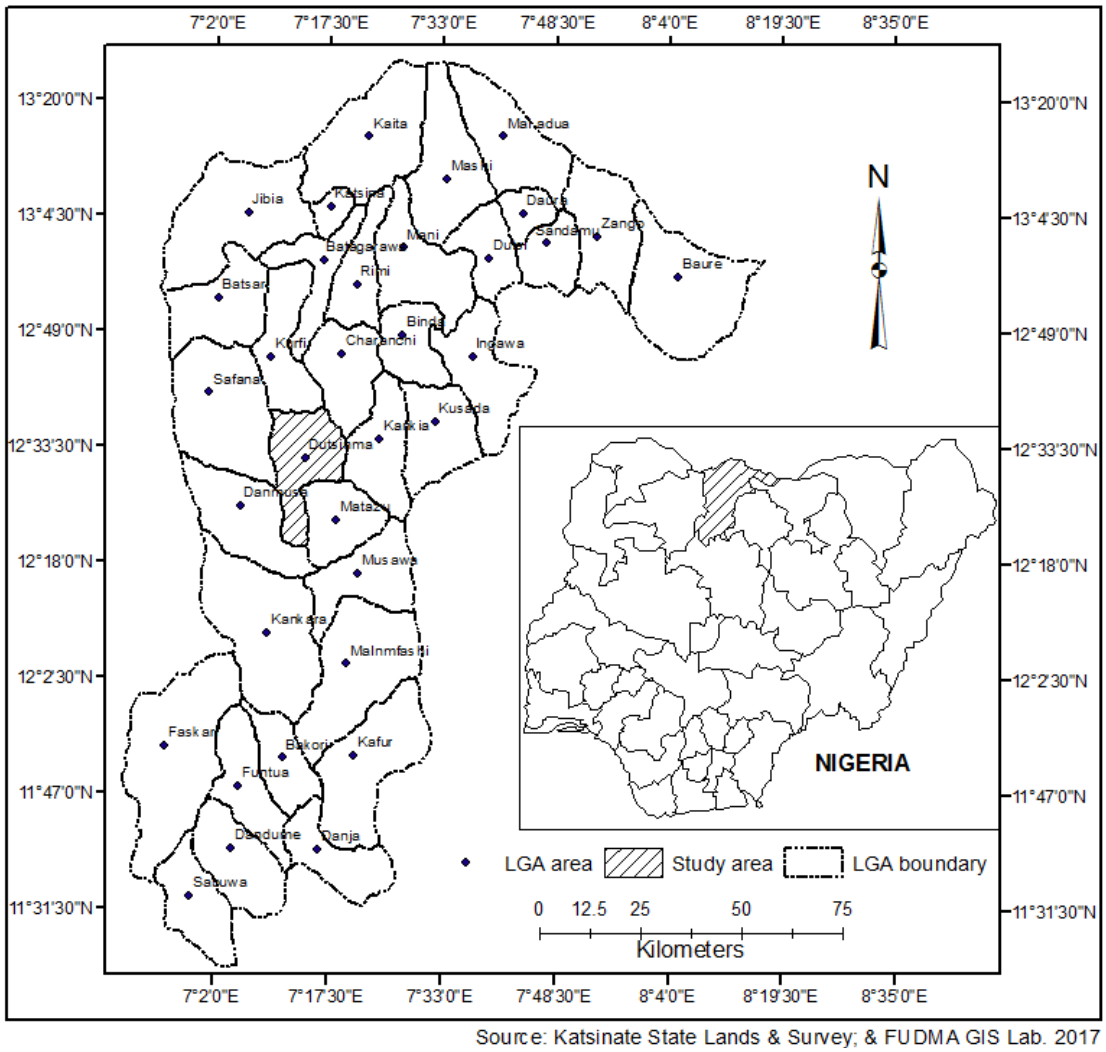
MATERIALS AND METHODS

Description of Study Area/Location

Dutsin-Ma LGA is located at the central part of Katsina state, and lies on Latitude 120 26′N and longitude 07 29′ E (Abaji, *et al.,* 2012). With estimated area of 552,323 km, and it is bounded in the North by Kurfi, Charanchi and Kankia LGAs. Matazu in the South-east, Safana and Dan-musa from the west (Fig.1). The climate of Dutsin-Ma is as classify by the Koppens classification is semiarid, tropical wet and dry climate. The climate patterns of Dutsin-Ma signify two main alternative seasons: that is the dry season and wet season. The rainy season is between April to September every year, which a time fluctuates in terms of onset and cessation. The average annual rainfall is about 700mm, and the pattern of the rainfall in the area is highly variable. This can result in a severe wide spread drought that can pose serious economic constrain (Abaji, *et al.,* 2012).

The mean annual temperature ranges from 29^{O}C to 31^{O}C, April and May is the highest temperature and the lowest in December - February. The highest amount of evaporation occurs during the dry season. The vegetation of the study area is the Sudan- Savanna type which combines the characteristics and species of both Guinea and Sahel Savanna (Tukur *et al.,* 2013).

The area is chosen because most households depend on rain water for consumption and their domestic use, and open fields and farmlands is a common practice observed in this area. Apart from boreholes and tap water in few households, sources of water for drinking and domestic uses during rainy season come mainly from, rain water. This water is used for agriculture, human consumption, various industrial activities and domestic purposes.



Source: Katsinate State Lands & Survey; & FUDMA GIS Lab. 2017

Figure 1: Map of Katsina State showing Dutsin-Ma Local Government Area

Sampling

Rain Water samples from Dutsin-Ma local government area would be obtained during rainy (early raining season, middle raining and late raining season). Sampling was conducted in the rainy seasons from May 2022 to October 2022. The water samples were collected using in a polyethylene container that were previously cleaned with detergent, rinsed with tap water and soaked in 0.1M HNO_3 for 24 hours and finally rinsed with deionized water prior to usage (Ademoroti, 1996). Four separate water sample were collected in 1000cm^3 capacity plastic bottles from each of the sampling locations.

Sample Treatment

Water sample bottles containing the rain water samples were stored in the refrigerator set at about 4°C prior to the analysis (APHA, 1998).

Physicochemical properties

Physicochemical parameters which would be studied include: pH, temperature, total dissolved solid (TDS), turbidity and anions concentration which would include Nitrate and Nitrite. Each parameter was measured in triplicates from which the mean and standard deviation counts would be determined.

Determination of pH

pH would be measured using the HANNA pH 210 Microprocessor pH meter. The pH meter would be calibrated using the following procedures. Three (3) pH buffers would be prepared (4.0, 6.0 and 7.0). The

pH electrode would be dipped into each of the three buffers prepared and calibration solutions would be save. The actual pH of the samples would be recorded after a stabilized reading was noted on pH meter (APHA, 1998).

Determination of Total Dissolve Solids (TDS)

50 $cm^3$of water samples would be placed into pre-weighed dishes and evaporated to dryness at 103 °C on a steam bath. The evaporated samples would be dried in an oven for 1 hour at 105 °C and cooled in desiccators and record for constant weights. The difference in the weights of Total Solids (W_1) and Total Suspended Solids (W_2) expressed in the same unit gives Total Dissolved Solids (APHA,1998).

Calculation:

Total Dissolved Solids (TDS)=W_1 - W_2 X1000/Sample volume (cm^3)

W 1 = Weight of total solids + dish;

W 2 = Weight of total suspended solids.

Determination of Turbidity

Stock turbidity suspension would be prepared by dissolving 1.0 g hydrazine sulphate $(NH_2)_2.H_2SO_4$ in deionized water and diluted to 1000cm^3 mark in a volumetric flask. Also, 10g of Hexamethylenetetraamine would be dissolve in water and diluted to 1000 cm^3 mark in volumetric flask . 5cm^3 of each of these solutions would be pipetted into 100 cm^3 volumetric flask and mixed thoroughly. It would be corked and allowed to stand for 24hours in an incubator set at 25^{O}C. Then swirled gently and diluted to 100cm^3 mark. It would be thoroughly mixed and the turbidity of this suspension is 400 units. 40 units would be prepared by pipetting 10cm^3 stock turbidity suspension accurately into 100 cm^3 volumetric flask and diluted to 100cm^3 with turbidity free deionized water. Further dilution would be done to give 0, 10, 20, and 30 units which would be used for turbidity meter calibration. Water samples would be thoroughly shaked as to disperse the solid content and air bubbles were allowed to disappear. Water samples would be poured into turbidimeter tube to the brim and their readings would be taken.

Determination of Temperature

The temperature of the samples would be measured at the site of collection using a Brannan mercury thermometer using standard procedures (APHA, 2012).

Determination of nitrate in water

10cm^3 of each water samples would be pipetted into sample containers. The content of one (NitraVer 5 Nitrate) reagent powder pillow would be added to each wastewater samples. It would be stoppered and the cell shaken thoroughly for 1 minute. The sample concentration would be read for each wastewater at 500 nm after 5 minute using UV/Visible Spectrophotometer (HACH DR/2010). The blank sample would be treated in the same manner. The result in mg/L nitrate-nitrogen (NO_3-N) would be displayed.

Determination of nitrite in water

10cm^3 of the water would be pipetted into a sample container. The content of one sachet of the reagent powder pillow (NitriVer 3 Nitrite) would be added, stoppered and the cell would be shaken to dissolve the powder. The concentration would be read at 507 nm after 20 minutes using UV/Visible Spectrophotometer. The result in mg/L nitrite expressed as (NO_2-N) was displayed (APHA, 2012).

RESULT AND DISCUSSION

Table 1: Physicochemical analysis of harvested zinc roof water samples

Sampling period	pH	Turbidity	Temperature	TDS	Nitrate	Nitrites
May	5.94	2.60	27.90	0.37	5.4	0.052
June	5.82	2.61	28.61	0.91	5.7	0.056
July	5.92	1.57	28.45	0.56	5.2	0.050
August	5.80	1.21	28.20	0.61	4.8	0.046
September	5.67	1.60	28.00	0.45	4.5	0.042
October	5.92	1.35	27.90	0.71	4.3	0.040

Table 2: Physicochemical analysis of direct rain drop water samples

Sampling period	pH	Turbidity	Temperature	TDS	Nitrate	Nitrites
May	6.51	2.32	27.80	0.10	19.6	0.275
June	5.98	2.00	28.60	0.80	19.0	0.250
July	6.32	1.10	28.50	0.23	18.9	0.291
August	5.68	0.73	28.60	0.20	17.5	0.110
September	6.20	1.39	27.90	0.10	17.2	0.112
October	5.74	1.20	28.00	0.42	18.0	0.115

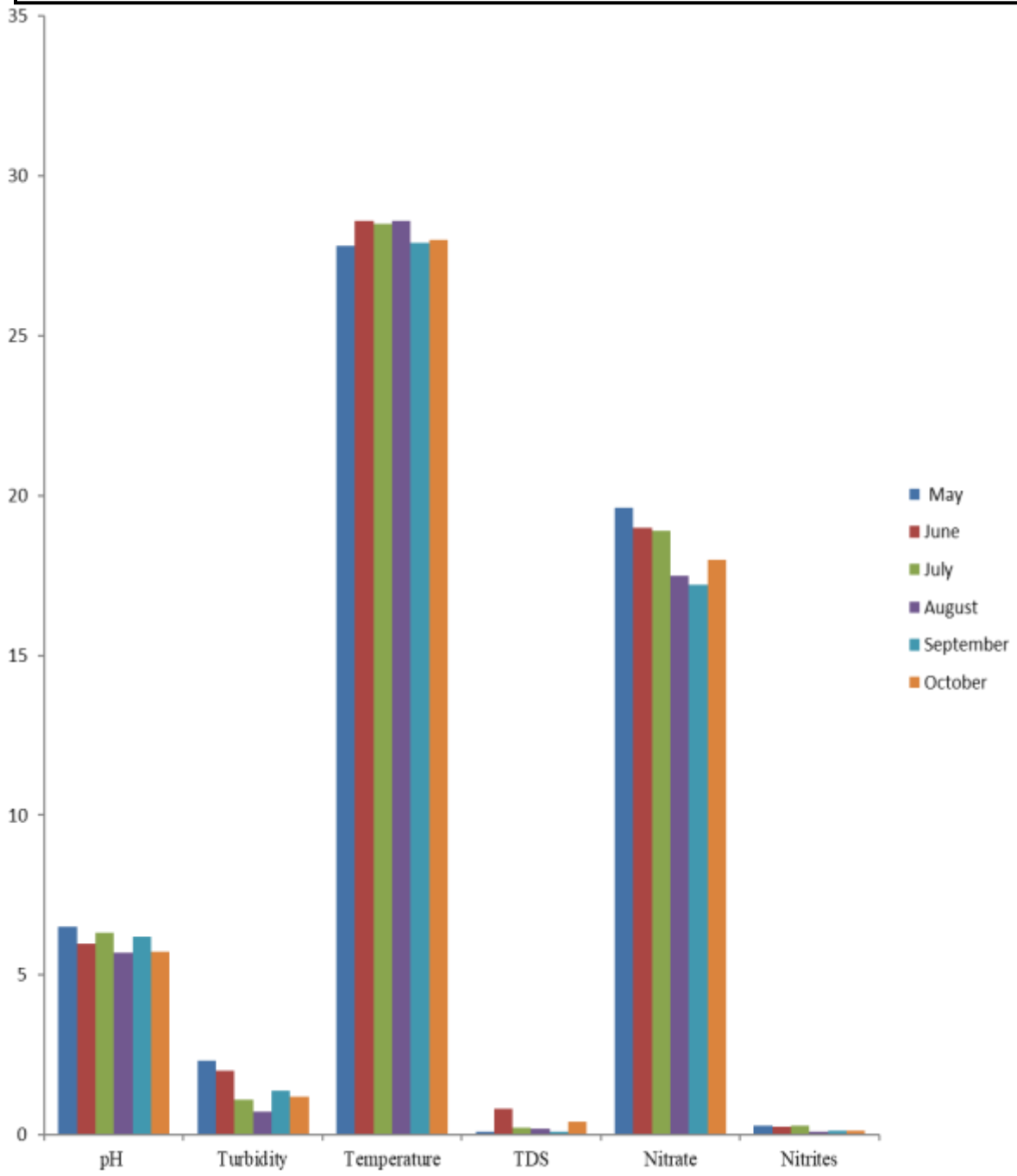


Fig 2: Physicochemical parameters of harvested zinc roof water samples

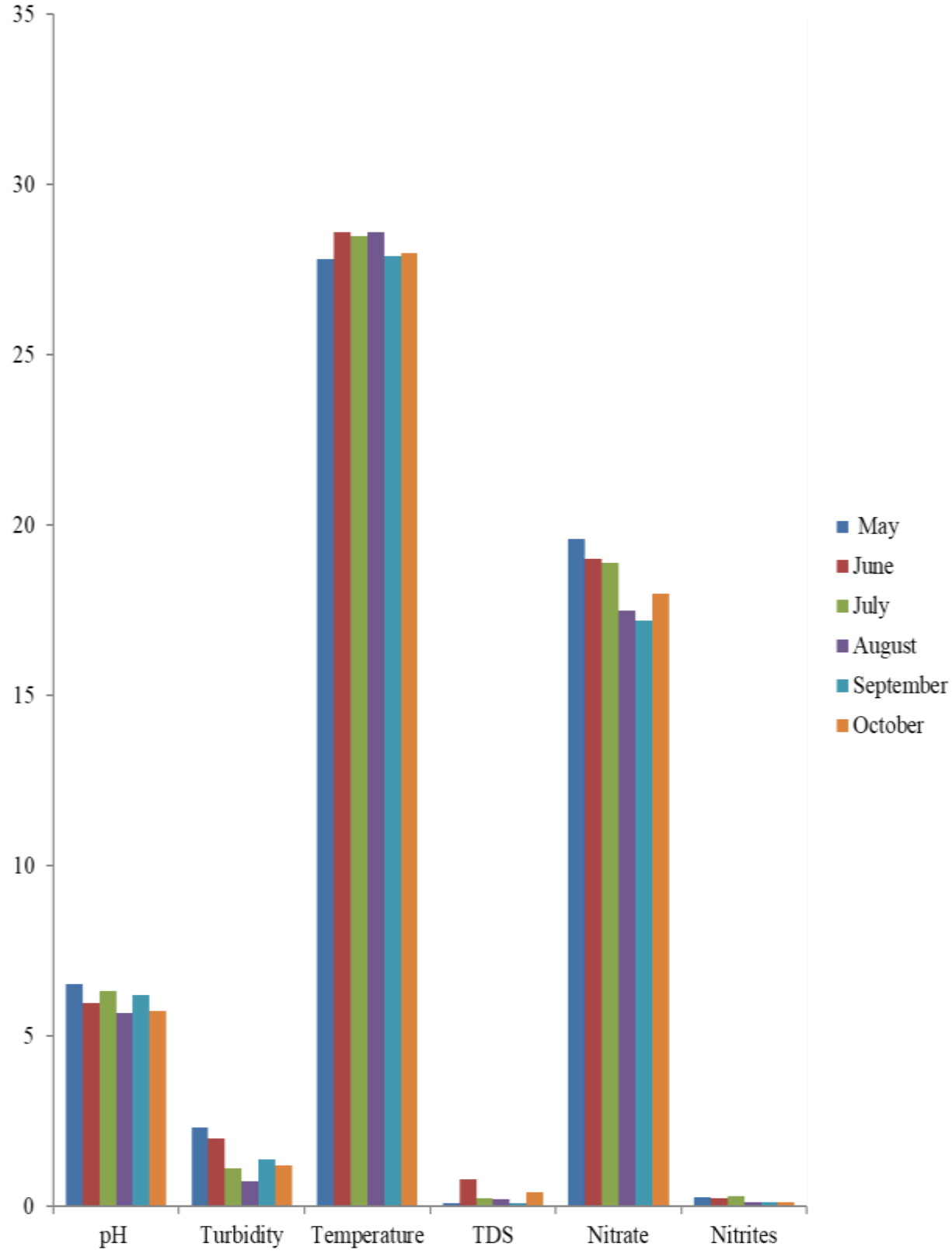


Fig 3: Physicochemical parameters of direct rain drop water samples

The average pH of rainwater samples collected from zinc roof types and direct raindrops ranged from 5.67 - 6.51. Zinc roofs ranged from 5.67 – 5.92 while Direct raindrops ranged from 5.68 -6.51 as shown in Figure 2 and 3. The pH values the samples analyzed was below the WHO allowable limit for portable water (6.5 - 8.5) except some water samples from zinc roofing sheet that fell within WHO allowable limit. The pH values obtained in this study Simmons *et al.*, (2001) with reported pH of 5.2 to 11.4 and Ikhioya *et al.*, 2015 who reported a range of 6.0 - 7.0 for harvested rainwater.

The average turbidity values ranged from 0.73 - 2.61 NTU. Turbidity values for zinc roof ranged from 1.35 - 2.61 NTU and Direct raindrops ranged from 0.73 – 2.32 NTU as shown in Figure 2 and 3. It was observed from the tables that turbidity was highest in water samples obtained from zinc roofs irrespective of the period of collection. However, all the values were less than the WHO maximum allowable limit for drinking water standard (5.00 NTU).

Figure 2 and 3 shows temperature of water samples from zinc roofs and direct raindrops the different roofing materials. The temperature in all analyzed samples ranged from 27.10 – 28.61^{O}C, Temperature values for direct raindrops ranged from 27.80 - 28.60 61^{O}C while zinc roofs ranged from 27.90 – 28.61^{O}C, as shown in Table 1 and 2.These temperature were lower than 32 – 34 ^{O}C levels reported by Uzoma *et al.*, 2015 in rain water samples from Etche LGA of imo state. This variation could be due to different in geographical location

Figure 2 and 3 shows total dissolved solids of direct raindrops and zinc roofs during the various rainfall periods in the study area. The TDS values ranged from 0.10 – 0.91 mg/L,

It was observed from table that water samples collected from zinc roofs gave the highest TDS irrespective of the period of collection. This could be traceable to the level of particles deposited on the roofing material. However, all the values were far less than the WHO maximum allowable limit for drinking water standard (500 mg/L).

Figures 2 and 3 shows nitrate and nitrite concentration of the zinc roofs and direct raindrops during the various rainfall periods in the study area. The nitrate levels ranged from 17.20 – 19.60 and 4.30 -5.70 mg/L for direct raindrops and zinc roofs ranged from , respectively. The values of nitrate obtained in this present study were higher than levels reported by Ikhioya *et al.*, 2015 but fells within WHO 50.00mg/L acceptable limits.

Nitrite values obtained from all the water samples analyzed fell below the WHO standard (3.00 mg/L), ranging from 0.040 – 0.056 mg/l for water collected from zinc roofs and 0.110 – 0.291 mg/L for water collected directly from raindrop (Figure 2 and 3)

CONCLUSION

This study was carried out to determine the quality of rainwater from zinc roofs and direct raindrops in Dutsin-Ma Local Government Area of Katsina State, Nigeria.The results obtained gave a range of 5.67 - 6.51 0.73 - 2.61 NTU, 27.10 – 28.61OC, 0.10 – 0.91 mg/L, 4.30 – 19.60, and 0.040 - 0.291mg/L for pH, turbidity, temperature, total dissolved solids, nitrate nitrite respectively. Rain water samples collected from zinc roofs gave high turbidity content than direct raindrops. Also, rain water from zinc roofs gave high TDS compared to direct raindrops. The Physico-chemical properties of the harvested water from the zinc roofs were considerably different from those of water collected directly from raindrop. However, Considering the result of the analysis, all the values of the Physico-chemical properties and anions content of the water samples were within the WHO maximum acceptable limit for drinking water

AVAILABILITY OF DATA AND MATERIALS: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

COMPETING INTERESTS: The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS: FM ran the experiment and interpreted the data and, MLD reviewed the literature, ran the data analysis and typed the manuscript. All the authors read the manuscript and approved it.

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